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Indian Standard

LIVE WORKING — EARTHING OR EARTHING AND SHORT-CIRCUITING EQUIPMENT USING LANCES AS A SHORT-CIRCUITING DEVICE — LANCE EARTHING

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Tools and Equipment for Live Working Sectional Committee, ET 36

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 1219(1993) (renumbered as IEC 61219) 'Live working — Earthing or earthing and short-circuiting equipment using lances as a short-circuiting device — Lance earthing' issued by the International Electrotechnical Commission was adopted by the Bureau of Indian Standards on the recommendation of the Tools and Equipment for Live Working Sectional Committee (ET 36) and approval of the Electrotechnical Division Council.

This International Standard IEC 61219 applies to equipment for temporary earthing or earthing and short circuiting of electrically isolated parts of a.c. installations.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations.

In the adopted standard, certain terminology and conventions are not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards the current practice is to use a point (.) as the decimal marker.

Only the English text of the International Standard has been retained while adopting it as Indian Standard, and as such the page numbers given here are not the same as in IEC Publication.

CROSS REFERENCES

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their places are listed below, along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050-151(1978) International Electrotechnical Vocabulary (IEV) — Chapter 151: Electrical and magnetic devices	IS 1885 (Part 74) : 1993 Electrotechnical vocabulary: Part 74 Electrical and magnetic devices	Identical
IEC 60060-1 (1989) High-voltage test techniques — Part 1 : General definitions and test requirements	IS 2071(Part 1) : 1993 High voltage test techniques: Part 1 General definitions and test requirements (*second revision*)	do
IEC 60298 (1990) A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	IS 3427 : 1997 AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV (*first revision*)	do
IEC 60410 (1973) Sampling plans and procedures for inspection by attributes	IS 2500 (Part 1) : 2000 Sampling procedure for inspection by attributes: Part 1 Sampling schemes indexed by acceptance quality limit (AQL) for lot by lot inspection (*third revision*)	Not equivalent

(*Continued on third cover*)

Indian Standard

LIVE WORKING — EARTHING OR EARTHING AND SHORT-CIRCUITING EQUIPMENT USING LANCES AS A SHORT-CIRCUITING DEVICE — LANCE EARTHING

1 Scope

International Standard IEC 1219 applies to equipment for temporary earthing or earthing and short-circuiting of electrically isolated parts of a.c. installations, the disconnection of which has been verified including the absence of voltage, for the protection of workers while work is in progress using lance(s) (see 3.2.2) as the earthing or earthing and short-circuiting device. The standard specifies the performance and safety requirements and tests for lance devices with matching fixed contacts, guiding arrangements, enclosure, insulating elements and earthing cables, if any.

The characteristics of the earthing equipment covered by this standard should be defined on the basis of the intensity and duration of the current, and an voltage when needed for insulation purposes. IEC 855 provides the electrical requirements for separate insulating elements of the equipment.

Component types or configurations are not specified but should comply with the electrical and mechanical requirements of this standard.

This standard is restricted to equipment using copper bars, aluminium bars or iron bars as short-circuiting medium.

NOTE - This standard is not applicable to devices containing short-circuiting cables, which follow the requirements given in IEC 1230.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(151): 1978, *International Electrotechnical Vocabulary (IEV) - Chapter 151: Electrical and magnetic devices*

IEC 60-1: 1989, *High-voltage test techniques - Part 1: General definitions and test requirements*

IEC 298: 1990, *A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 410: 1973, *Sampling plans and procedures for inspection by attributes*

IEC 439-1: 1992, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 479-1: 1984, *Effects of current passing through the human body – Part 1: General aspects – Chapter 1: Electrical impedance of the human body – Chapter 2: Effects of alternating current in the range of 15 Hz to 100 Hz – Chapter 3: Effects of direct current*

IEC 855: 1985, *Insulating foam-filled tubes and solid rods for live working*

IEC 1138: 1992, *Live working – Cables for portable earthing and short-circuiting equipment*

IEC 1230: 1993, *Live working – Portable equipment for earthing or earthing and short-circuiting*

IEC 1235: 1993, *Live working – Insulating follow tubes for electrical purposes*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 *Tests*

3.1.1 Type test

A test of one or more devices made to a certain design to show that the design meets certain specifications. [IEV 151-04-15]

3.1.2 Sampling test

A test on a number of devices taken at random from a batch. [IEV 151-04-17]

3.1.3 Routine test

A test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria. [IEV 151-04-16]

3.1.4 Acceptance test

A contractual test to prove to the customer that the device meets certain conditions of its specification. [IEV 151-04-20]

3.2 *Special terms*

3.2.1 Lance earthing

Earthing equipment using lance(s) as devices for earthing or earthing and short-circuiting (see figures 1 to 4). Comprises lance(s), lance contacts on the conductors to be earthed or earthed and short-circuited, earth connection, guiding components and insulating handle(s) or earthing pole(s).

3.2.2 Lance

Lance-shaped conductive rod used for earthing or earthing and short-circuiting by pushing it longitudinally and guiding it into lance contacts. Comprises a conductive part and an insulating handle with hand guard, an earthing pole or a coupling for a separate insulating element (see figures 1 to 4).

3.2.2.1 Single lance

Single- or multi-phase device with one lance only (see figures 1, 3 and 4).

3.2.2.2 Multiple lance

Multi-phase device with a number of lances electrically and mechanically connected together into a rigid multi-pole structure by a short-circuiting and mechanically uniting frame (see figure 2).

3.2.3 Multi-phase lance device

The general ways to assemble a multi-phase lance device are:

a) A single lance used as the device for earthing and short-circuiting is:

- connected to an earthing cable, pushed sequentially and guided into the line lance contacts of the conductors to be earthed and short-circuited (see figure 1a);

or

- pushed sequentially and guided through an earthing lance contact into the line lance contacts of the conductors to be earthed and short-circuited (see figure 1b).

b) With a set of single lances used as a device for earthing and short-circuiting by pushing and guiding each lance sequentially through an earthing lance contact into the line lance contact of one of the conductors to be earthed and short-circuited (see figure 3).

c) With a multiple lance used as a device for earthing and short-circuiting. It is connected to an earthing cable and pushed simultaneously and guided into the lance contacts of the conductors to be earthed and short-circuited (see figure 2).

NOTES

1 A set of single lances can form a multi-phase lance device only when using earthing lance contacts (see notes in clause 1 and 3.2.7).

2 A multiple lance using earthing lance contacts has no advantages over a set of single lances.

3.2.4 Single-phase lance device

Single lance used for earthing and short-circuiting a single-phase system by being pushed sequentially and guided through an earthing lance contact into the line lance contact of the conductor to be earthed and short-circuited (see figure 4).

3.2.5 Earth connection

Connection between a lance and the earthing system. Comprises earth clamps, earthing lance contact or earthing cable and sometimes parts of supporting structures (see figures 1 to 4 and 7).

3.2.6 Lance contact

Fixed installation contact, specially arranged for the guiding, connection and securing of a lance.

3.2.6.1 Line lance contact

Lance contact connected to the conductor to be earthed or earthed and short-circuited (see figures 1 to 4).

3.2.6.2 Earthing lance contact

Lance contact connected to the earthing system (see figures 1b, 3 and 4).

3.2.7 Earthing cable

Cable used for earth connection (see figures 1a and 2).

NOTE - A cable forming part of a short-circuiting device is defined as a short-circuiting cable and cannot be referenced to this standard.

3.2.8 Insulating element

Hand-held insulating component for bringing and connecting a lance to parts of electrical installations for earthing or earthing and short-circuiting purposes.

3.2.8.1 Insulating handle

Insulating element comprising a short grip, a handguard and a coupling, fixed or detachable, to a lance (see figure 6).

3.2.8.2 Earthing pole

Insulating element comprising an insulating rod, foam-filled tube or hollow tube with fixed or detachable coupling to a lance (see figure 3b).

3.2.9 Short-circuiting device

Device for interconnecting conductors for short-circuiting purposes.

NOTE - The interconnection may be made partly through the earthing system (see figures 3 and 7).

3.2.10 Rated current I_r and rated time t_r

Values assigned to a lance earthing or part of it, to define the highest r.m.s. value of current and the highest Joule-integral ($I_r^2\ t_r$) that it can resist without unacceptable effects. The values apply only to those parts designed to withstand short-circuit current.

3.2.11 Rated conditional short-circuit current

Value of the prospective short-circuit current that a lance earthing, protected by a current-limiting switching device, can satisfactorily withstand for the operating time of this device under specified test conditions (see 4.6 of IEC 439-1).

3.2.12 Peak current I_m

Peak value of the highest current during the transient period following initial energizing of the circuit.

4 Electrical characteristics

Each component of a lance earthing that is exposed to short-circuit current is characterized by rated current I_r and rated time t_r.

Six values of rated time are standardized:

3; 2; 1; 0,5; 0,25 and 0,1 s

I_r shall be specified for one of these standard times or as a rated conditional short-circuit current for a specified combination with an effective current-limiting protection.

No part of a lance earthing shall be exposed to a current or Joule-integral higher than that defined by its rated values.

NOTE - The equipment may be used for a longer short-circuit time than its rated time if the Joule-integral $I_r^2\ t_r$ is not exceeded.

5 Requirements

5.1 *General*

Equipment shall permit safe and simple earthing and short-circuiting of electrical installations (see annex C).

Devices, when installed according to instructions for use, shall be able to withstand all stresses from fault currents that they will be exposed to in practice without causing electrical, mechanical, chemical or thermal danger to persons. For indoor use, accepted temperatures and materials shall be co-ordinated so as to avoid any interference with the evacuation of personnel to avoid harmful concentrations of toxic vapours as well as serious, permanent damage to installations or buildings.

Reliable current-limiting fuses and circuit breakers are available for low voltage. If a low-voltage lance earthing designed for continued use is effectively protected by a current-limiting switching device, the requirements can be based on the rated conditional short-circuit current.

Equipment for continued used after short-circuit exposure shall, as an additional requirement, be in perfect condition after exposure to the severest short-circuit stresses for which it is designed.

The following clauses specify the requirements and tests necessary to verify that a device meets these requirements (see table 2). Agreement may be made between manufacturer and customer on additional requirements and tests prescribed in the customer's specification.

With respect to climatic conditions, equipment for stationary use in normal indoor atmosphere shall refer to a temperature range + 5 °C to + 55 °C. For mobile and outdoor equipment, normal use shall refer to a temperature range – 25 °C to + 55 °C. Two special categories for high (W) and low (C) temperature use are included (see table 1).

Table 1 – Special temperature categories

Category	Temperature range
Warm (W)	– 5 °C to + 70 °C
Cold (C)	– 40 °C to + 55 °C

5.2 *Earthing cables*

Earthing cables shall be sized for expected fault currents.

For mechanical reasons the conductor shall have as a minimum a 16 mm^2 copper equivalent cross-section.

The cable shall have an insulating cover for mechanical and chemical protection and shall be connected in such a way as to ensure reliable contacts and excellent fatigue resistance. This is achieved by selecting earthing cables according to IEC 1138 and end fittings according to 4.4 of IEC 1230.

NOTE - There are two common practices regarding the colour of the covering:

a) a bright colour, such as orange or red, to increase the visibility of the device. Preferences differ among users;

b) transparency to permit inspection of the conductor for signs of corrosion or surface strand damage, although such transparency is usually lost after repeated use.

Compliance shall be verified by testing in accordance with relevant parts of IEC 1230 and by visual inspection.

5.3 *Lances, lance contacts and guiding components*

After full insertion into lance contacts, the lance earthing shall protect against dangerous voltage and electric arc due to accidental energization. Lances, lance contacts and guiding components shall be co-ordinated to give reliable securing and contact even under short-circuit conditions.

Lances (including short-circuiting frames of multiple lances), lance contacts and guiding components shall withstand the short-circuit stresses for which they are designed as well as the push, pull, bending and torsional stresses arising in normal use without any harmful influence on contacts by reduction of contact surfaces or contact pressures.

Lances designed for continued use after short-circuit exposure shall have their current limited to the following values:

- copper lance: 180 A/mm^2;
- aluminium lance: 120 A/mm^2;
- steel lance: 65 A/mm^2.

Compliance shall be verified by tests according to 6.3 and 6.4 and by visual inspection.

5.3.1 *Installing and removing of lances*

The lance shall be designed to facilitate reliable operation with reasonable physical effort by the user.

Lances shall be co-ordinated with lance contacts and other guiding components to attain accurate and smooth application.

In lance earthings using earthing lance contacts, the lance shall always enter the earthing lance contact before line lance contacts.

The forces needed to insert and remove a lance shall not exceed 400 N. If the equipment is designed for continued use after short-circuit exposure, this requirement shall be fulfilled even after such exposure. It may be impossible or unsuitable to size lances for continued use even in installations where reduction of outage time is very determinant. If so, a special agreement between customer and manufacturer on the removability of lances after short-circuit exposure may be required.

The lance shall meet a mechanical stop in the fully inserted position. Another stop may be arranged for a single lance in systems not solidly earthed with disconnecting earth fault protection in a position where it has reached full contact with the first line lance contact. The aim of this is to give a time margin for disconnection before short-circuiting.

Stops shall withstand reasonable excess forces.

Compliance shall be verified by tests in accordance with 6.2 and 6.3, by measuring and checking manually and by visual inspection.

5.3.2 *Blocking and locking of lances in fully inserted position*

Lance earthings shall be equipped with arrangements for blocking of the lance in fully inserted position. The blocking shall be of a type that is not affected by vibrations. Lance earthings for enclosed switchgear or controlgear assemblies shall have arrangements for making or completing the blocking with a padlock with a 5 mm solid shackle.

Blockings shall withstand reasonable excess forces.

Compliance shall be verified by test in accordance with 6.3, by checking manually and by visual inspection.

5.3.3 *Insulating elements*

The insulating elements used with lances are insulating handles and earthing poles, fixed to the lance conductor or detachable.

Insulating elements shall offer protection against puncture, flash-over and creepage current at the voltages to which they are exposed in practice.

Insulating handles are permitted for voltages ≤ 36 kV. Earthing poles shall be used for voltages > 36 kV and wherever necessary for raising and reaching.

Insulating handles shall have a grip and a handguard that prevents the hand from sliding out on the bare conductor (see figure 6). The handguard height shall be at least 20 mm. With regard to pushing and pulling forces, the handle shall, if necessary, be suitable for two-handed operation. The minimum grip length shall be 115 mm for one-hand lances and 220 mm for two-hand lances.

Where a problem is present for raising and reaching, for instance open switchgears and overhead lines, an earthing pole is normally preferable. If the operator is not sufficiently distanced from live parts by the length of the lance, the earthing pole length shall be given the necessary additional length. Rules for the selection of earthing poles are given in IEC 1230, annexes A and C (see also IEC 855 and 1235)*. Interim rules for the selection of earthing poles are given in annexes A and C of IEC 1230.

There shall be no conductor along the earthing pole, either outside or inside.

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* This document is under consideration by Technical committee 28.

Detachable insulating handles and earthing poles shall be secured against unintentional loosening.

All insulating handles and earthing poles including couplings shall withstand reasonable excess forces without failing or being damaged.

Compliance shall be verified by testing according to relevant parts of earthing pole standards, by tests in accordance with 6.3 and 6.5, by measuring and checking manually and by visual inspection.

5.4 *Insulation co-ordination with assemblies*

Insulating parts of a lance earthing integrated in a switchgear or controlgear assembly shall respond to relevant parts of assembly standards.

Compliance shall be verified by testing according to relevant parts of assembly standards.

5.5 *Co-ordination with assembly enclosure*

Installation of lance earthing in an enclosed switchgear or controlgear assembly shall not reduce its degree of enclosure when the lance is inserted or removed.

Compliance shall be verified by testing according to relevant parts of assembly standards and visual inspection.

5.6 *Marking*

5.6.1 *General*

- Marking shall be clearly legible.
- Marking letters shall be at least 3 mm high.
- Marking shall be durable.

Compliance shall be verified by test in accordance with 6.6 and by visual inspection.

5.6.2 *Mandatory marking*

Lances, lance contacts, guiding components and detachable insulating elements shall, if possible, be marked with at least the following markings:

- manufacturer's name or trade mark;
- model or type reference for the component;
- month and year of manufacture.

Compliance shall be verified by visual inspection.

5.6.3 *Data for electrical characteristics*

Data for electrical characteristics given in the manufacturer's performance description will only be given in the marking when there is agreement between customer and manufacturer.

Data shall be given for every mode of application of a lance earthing stated by the manufacturer. Modes of application can be phase number and phase distance variations, for continued use or not after short-circuit exposure, etc. The following data shall be given in the manufacturer's description and to the extent it is agreed between customer and manufacturer, in the marking:

- rated current I_r (kA r.m.s.), over rated time t_r (s). For example 10 kA/0,5 s;

- "1 kV" is added after the other ratings for equipments tested with *n*-values less than 2,5 according to table 3.

A low-voltage lance earthing, to be used only when protected by a specified effective current-limiting switching device, is described in detail for a given application by:

- its rated conditional short-circuit current, kA r.m.s.;
- the characteristics of the protection.

Compliance shall be verified by visual inspection.

5.7 *Manufacturer's instructions for use*

The manufacturer's instructions for use shall include at least the following statements:

- explanations of markings and, when relevant, instructions for assembly;
- guidelines for maintenance and inspection;
- instructions for installation and tightening;
- torque values and securing instructions for auxiliary fasteners, which may be loosened by the customer;
- limitation, if any, of rated values for indoor use;
- temperature category(-ies) covered;
- restriction, if any, to indoor use;
- specification of any additional characteristic of the device indicated by the manufacturer;
- re-assembly service by the manufacturer after thorough inspection;
- necessity for disposal of devices which have been exposed to short-circuit current, unless they are gauged for continued use after this exposure.

Compliance shall be verified by visual inspection.

6 Tests

6.1 *General*

A list of tests with references to corresponding subclauses is given in table 2. Agreement may be made between customer and manufacturer on additional tests prescribed in the customer's specification.

Lance earthings that are designed to be included in a specified way in a given switchgear or controlgear assembly shall, as far as possible, be tested together with the assembly and according to applicable parts of the assembly standards. Otherwise, the test shall be made in a test set-up where relevant parts of the àssembly are reproduced in their entirety.

Lance earthings that are designed for various installations may be short-circuit current tested in standardized test set-up(s) (see figures 5 and 7) representing within reasonable limits the worst possible conditions. The test shall not be repeated after installation.

Components which have been evaluated by destructive tests shall not be re-used.

Tests shall be carried out at temperatures between 5 °C and 40 °C and regardless of humidity, unless otherwise specified.

NOTE - This broad range of climatic conditions is specified because outdoor testing may sometimes be preferable or necessary.

Unless otherwise specified, electrical tests shall be carried out in accordance with high-voltage test techniques (see IEC 60-1 and IEC 60-2).

Table 2 – List of tests referred to subclauses and test categories

Test number	Nature of test	Subclause		Description	Testing method	Category of test		
		Requirement	Test			Type	Sampling	Routine
1	Non-destructive	5.1, 5.3.1, 5.3.3	–	Checking that the equipment is suitable for the prescribed climatic conditions and fields of application	Visual inspection Manual checking Measuring			X X X
2	Non-destructive	5.2.5.3	–	Checking material and cross-section designations of conductors	Visual inspection			X
3	Non-destructive	5.2	–	Checking that cables with end fittings and connections respond to IEC 1230	Documentation			X
4	Non-destructive	5.3.3	–	Checking that earthing poles respond to IEC 1230	Documentation			X
5	Non-destructive	5.3.2	–	Checking blocking functions and locking arrangements	Manual checking Visual inspection			X X
6	Non-destructive	5.3.3	–	Checking dimensions of insulating handles	Measuring Visual inspection	X	X	X

(continued)

Test number	Nature of test	Subclause		Description	Testing method	Category of test		
		Requirement	Test			Type	Sampling	Routine
7	Non-destructive	5.3.1	6.2	Lance inserting and removal test	Testing Manual checking	X	X	 X
8	Destructive	5.3	6.3	Mechanical strength test	Testing	X	X	
9	Destructive	5.1, 5.3	6.4	Short-circuit current test	Testing	X	1)	
10	Non-destructive	5.3.3, 5.4	6.5	Dielectric test on insulating handles	Testing	X	X	
11	Non-destructive	5.4	-	Checking insulation co-ordination with assemblies	2)			
12	Non-destructive	5.6	-	Checking co-ordination with assembly enclosure	2)			
13	Non-destructive	5.6	-	Checking of marking	Visual inspection			X
14	Non-destructive	5.6.1	6.6	Testing durability of marking	Testing	X	X	
15	Non-destructive	5.7	-	Checking that the manufacturer's instructions for use are delivered and acceptable	Visual inspection			X

[1] Only on devices designed for continued use after short-circuit exposure.

[2] Included in assembly testing.

The tests to verify the characteristics of a lance earthing include:

- type tests (see table 2 and 3.2.1 and 6.1.1);
- sampling tests (see table 2 and 3.2.2 and 6.1.2);
- routine tests (see table 2 and 3.2.3 and 6.1.3).

6.1.1 *Type tests*

The manufacturer shall provide evidence to the customer that all type tests given in table 2 and applicable to a given type of lance earthing have been successfully carried out.

Unless otherwise specified, these tests shall be carried out on one specimen.

6.1.2 *Sampling tests*

Sampling test shall be carried out at the instigation of the manufacturer.

The manufacturer shall provide evidence to the customer that all sampling tests given in table 2 and applicable to a given type of lance earthing have been successfully carried out. The customer may participate in the sampling selection if this is indicated in the customer's specification.

All sampling test defects shall be regarded as major defects.

The sampling test shall follow the procedures given in IEC 410, with, however, a single sampling plan for normal inspection in accordance with annex A.

6.1.3 *Routine tests*

Routine tests shall be made to detect faults in material, workmanship or transportation. Lance earthings, delivered either installed in assemblies or as separate apparatus shall be tested in factory at the manufacturer's instigation. Inspection shall be made at the installation site at the instigation of the party responsible for assembly and installation, to ensure that the delivery has not suffered from any transportation accident.

6.1.4 *Acceptance tests*

Unless otherwise specified, the non-destructive routine tests given in table 2 shall be used as acceptance tests.

6.2 *Lance insertion and removal test*

The test shall be carried out in an assembly or test set-up arranged with all lance contacts, other guiding components and end-stop included in the lance earthing to be tested.

All components used in the test shall be clean and dry.

The pushing and pulling forces shall be measured as the lance is inserted to end-stop and then removed again.

For a lance earthing designed for disposal after exposure to short circuit, the test shall be made once. For a lance earthing designed for continued use after short-circuit exposure, the test shall be repeated between and after the short-circuit current tests according to 6.4.

The test is considered successful if the forces given in 5.3.1 are not exceeded.

6.3 *Test on reliability of stops and ability of lances, couplings, handles and stops to withstand connecting forces*

The test shall be performed on one specimen, complete with lance, lance contacts, other guiding components, stops, insulating elements and couplings, by full insertion and full removal of the lance 50 times.

Each time the lance meets a stop, a force of 800 N shall be applied for 10 s before the stop is released or the movement reversed.

Stops shall be approached with a speed not lower than 1 m/s.

The test is considered successful if no stop is found to be faulty and no component has any breakage or deformation that may impair its continued use.

6.4 *Short-circuit current tests*

6.4.1 *General*

6.4.1.1 *Test current*

Tests should be performed with a.c. voltage with the same number of phases as the lance earthing is designed for and at a frequency of 45 Hz to 65 Hz. If multi-phase equipment can be tested only with single phase, each test shall be performed between two conductors in all possible combinations with a current magnitude that results in at least the same mechanical and thermal stresses. This current magnitude shall be determined by accurate calculation.

6.4.1.2 *Test arrangements*

Lance earthings shall be tested preferably in a well-defined switchgear or controlgear assembly in relevant parts which are identical with those used in practice and according to relevant parts of assembly standards.

Lance earthings that are designed for various installations may be tested for short-circuit current in standardized test set-up(s) (see figures 5 and 7) specified in 6.4.1.3.

The distance from lance contact to test current feed-in point shall, as a minimum, be:

- 1 m ≤ 36 kV;
- 2 m > 36 kV.

Feeding, earthing and short-circuiting conductors outside the feed-in point shall be arranged so as not to transmit appreciable forces to the tested device.

6.4.1.3 *Standardized test set-ups*

The standardized test set-up(s) shall have the same number of phases as the system(s) for which the lance earthing is designed. The earth conductor of a solidly earthed system is considered as a phase conductor.

In all standardized test set-ups, the lance contacts shall be turned in the direction that offers the weakest grip under short-circuit conditions.

The following types of devices are considered:

a) multi-phase earthing using:
   1) a single lance (the use is limited to voltages ≤ 36 kV) (see figure 1);
   2) a multiple lance (the use is limited to voltages ≤ 36 kV) (see figure 2);
   3) a set of single lances (the only type used for voltages > 36 kV) (see figure 3);

b) single-phase earthing (see figure 4).

In test set-ups for devices type a)1), a)2) and b), the conductors shall have the maximum distance permitted by the length of the lance (exemplified for type a)1) in figure 5).

The testing of devices type a)3) in standardized test set-ups (as shown for a three-phase arrangement in figure 7) shall follow the guidelines given in annex B.

6.4.1.4 *Documentation of the test*

During the short-circuit current test, the voltage and the current shall be registered with an oscillograph that has been calibrated prior to the test. The oscillogram is used to determine the peak current, Joule-integral, test time and current at the end of the test time.

A test report shall be drawn up which, in addition to the test results, shall give at least:

- a clear designation of the tested equipment;
- a description of the test arrangement, and if necessary photographs and/or drawings;
- an oscillogram with time trace and scales for test voltage and test current.

6.4.2 *Lance earthing for use without effective current-limiting protection*

The lance earthing is defined by its rated current over rated time I_r kA/t_r s, and its integrity after short-circuit exposure.

Current and time for the test is defined as follows:

- test current $I_t = I_r$;
- test time t_t = the time from initiation until a Joule-integral = $I_r^2 t_r$ has been imparted.

The test shall be performed with:

- test peak current $i_{tm} \geq nI_t$, where n shall be taken from table 3;
- Joule-integral $\geq I_t^2\ t_r$;
- test time, $t_t \leq 1{,}15\ t_r$;
- r.m.s. value of current, calculated by dividing the peak-to-peak current at the end of the test time by $2\sqrt{2}$, $\geq I_t$

The test shall be evaluated according to 6.4.4.

Table 3 – Peak current factor

Nominal system voltage kV	Test current I_t kA r.m.s.	Factor n
< 1	< 5	1,5
	> 5 – 10	1,7
	> 10 – 20	2,0
	> 20 – 50	2,1
	> 50	2,2
> 1	All	2,5

NOTE - Below 1 kV, the values of factor n have been chosen to suit the capacities of well-equipped laboratories.

6.4.3 *Low-voltage lance earthing for use with effective current-limiting protection and designed for continued use after short-circuit exposure*

The current-limiting device for the test shall be of the type defined by the manufacturer of the lance earthing and have the highest rated current recommended by him for the given rated conditional short-circuit current.

The lance earthing is defined by its rated conditional short-circuit current, limited peak current and limited Joule-integral. A lance earthing protected by current-limiting components (fuses or circuit breaker) is exposed to maximum dynamic and thermal stresses under different conditions. Maximum peak current and dynamic stress occur when the prospective short-circuit current is maximum, whereas maximum Joule-integral and thermal stress occur when the short-circuit current is minimum, i.e. at the longest fault current time permitted.

This necessitates separation of dynamic and thermal tests.

6.4.3.1 *Dynamic test (peak current test)*

Settings are made with additional devices short-circuiting the lance earthing and the current-limiting components. The impedance of the additional devices shall be negligible in relation to that of the total test circuit.

The following settings are made:

- test current I_t and test peak current i_{tm} are set as prescribed in 6.4.2, i.e. $I_t = I_r$ and $i_{tm} = n\ I_t$, where n is taken from table 3;
- voltage is set at about 110 % of the highest prospective voltage;
- the circuit breaker of the test equipment is set to disconnect well after the current-limiting protection to be tested together with the lance earthing.

When settings are made, with the additional short-circuiting devices removed and the lance fully inserted, the lance earthing shall be exposed to three dynamic tests. Between the tests, the equipment shall cool down, and the lance shall be checked to see that it can be removed and re-inserted in accordance with 5.3.1. The testing procedure varies with the type of current-limiting protection.

With fuses as current-limiting components, the test circuit shall be closed by a circuit breaker in the test equipment in such a way that each phase of the lance earthing is exposed to maximum peak current at least once. All fuses shall be replaced by new ones after each test.

With a circuit breaker as the current-limiting component, one test shall be initiated by closing the circuit breaker in the test equipment while the current-limiting circuit breaker to be tested together with the lance earthing, is in the closed position. In two following tests, the current-limiting circuit breaker shall close as well as open. The instant of closing is not important.

The test shall be evaluated according to 6.4.4.2.

6.4.3.2 *Thermal test (Joule-integral test)*

Each lance earthing that has passed the dynamic test shall be exposed to one test with maximum Joule-integral. The test shall be performed without current-limiting protection.

Unless otherwise prescribed by the manufacturer or agreed between customer and manufacturer, the test time shall be 5 s.

Voltage and power factor are arbitrary.

A lance earthing designed for use with fuses as current-limiting protection shall be tested with a current voltage of at least I_t, guaranteed to interrupt within 5 s for the type of fuse prescribed by the manufacturer of the lance earthing.

A lance earthing designed for use with circuit breaker for current-limiting protection shall be tested with a current voltage of at least I_t, guaranteed to activate protection within 5 s. If the protection has exchangeable measuring units, the one with the highest activating current shall be considered. If the protection cannot last 5 s, I_t shall be set at the value corresponding to the longest possible tripping time. If the protection can be used only for instantaneous tripping, the thermal test does not apply.

A varying test current shall not be less than I_t when the Joule-integral 5 I_t^2 has been imparted.

The test is started and interrupted with a circuit breaker in the test equipment.

After the test, it shall be checked that the lance(s) can be removed and re-inserted according to 5.3.1.

The test shall be evaluated according to 6.4.4.2.

6.4.4 *Test evaluation*

6.4.4.1 *Test evaluation for a lance earthing designed for disposal after short-circuit exposure*

The test is considered successful if the oscillogram indicates that:

- there is no current interruption during the test time;
- the values of peak current, Joule-integral, test time and current at the end of the test time are all in accordance with those prescribed in 6.4.2;
- the voltage curve has no irregularities indicating arcing during the test time and satisfies the requirements of zone 2, figure 5 of IEC 479-1;
- any special requirements for removability are fulfilled.

6.4.4.2 *Test evaluation for a lance earthing designed for continued use after short-circuit exposure*

The test is considered successful if the evaluation according to 6.4.4.1 is met and:

- no details, with special attention to insulators, contact surfaces and contact pressures, are affected in a way that impairs their continued use;
- contamination is not a hazard to the dielectric properties as specified in 5.4;
- no reduction of clearances or creepage distances has occurred;
- the lance insertion and removal forces match 5.3.1 between and after the tests.

6.5 *Dielectric tests*

6.5.1 *Parts of lance earthing to be included in switchgear or controlgear*

Parts of lance earthing to be included in switchgear or controlgear shall always be tested together with the equipment in accordance with relevant parts of switchgear or controlgear standards.

6.5.2 *Insulating handles – low voltage (less than 1 000 V)*

Insulating handles of low-voltage lances shall be covered with metal foil (see figure 6) or equivalent arrangements and tested with 5 250 V in accordance with 8.2.2 of IEC 439-1.

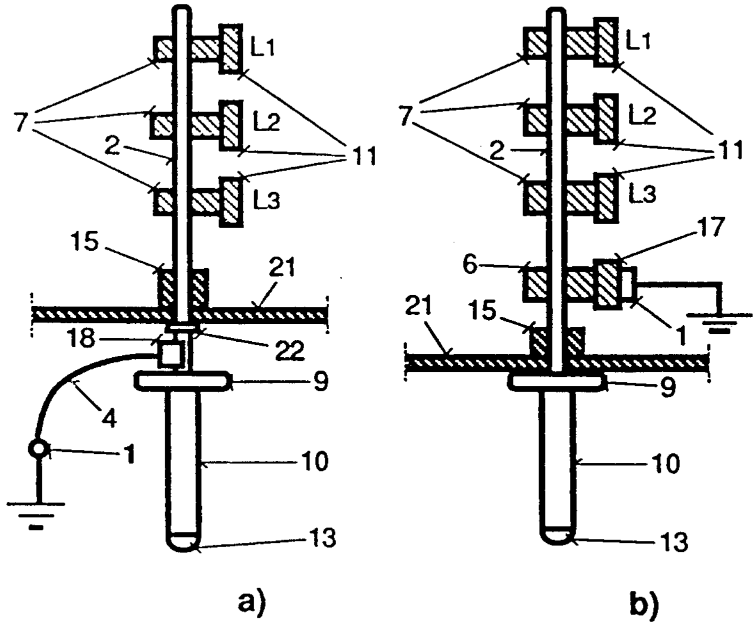
6.5.3 *Earthing poles*

Testing in addition to that prescribed in the specific standards for different types of separate insulating elements is not necessary.

6.6 *Testing durability of marking*

The durability of marking shall be tested by rubbing the marking for 15 s with a piece of lint-free cloth soaked in soapy water and then rubbing it for a further 15 s with a piece of lint-free cloth soaked in acceptable solvents.

The test is considered successful if the marking is still clearly legible.

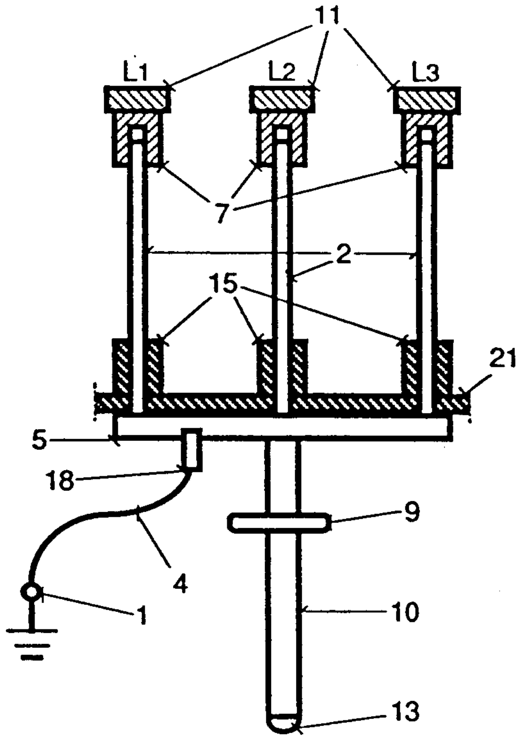


1	Earth clamp
2	Lance
4	Earthing cable
6	Earthing lance contact
7	Line lance contact
9	Handguard
10	Insulating handle
11	Installation conductor
13	End cap of handle
15	Guiding component
17	Earthed bar (part of earthing system)
18	Earthing cable connection
21	Mechanical support
22	End stop

Figure 1 – Illustrations of multi-phase earthing and short-circuiting with one single lance

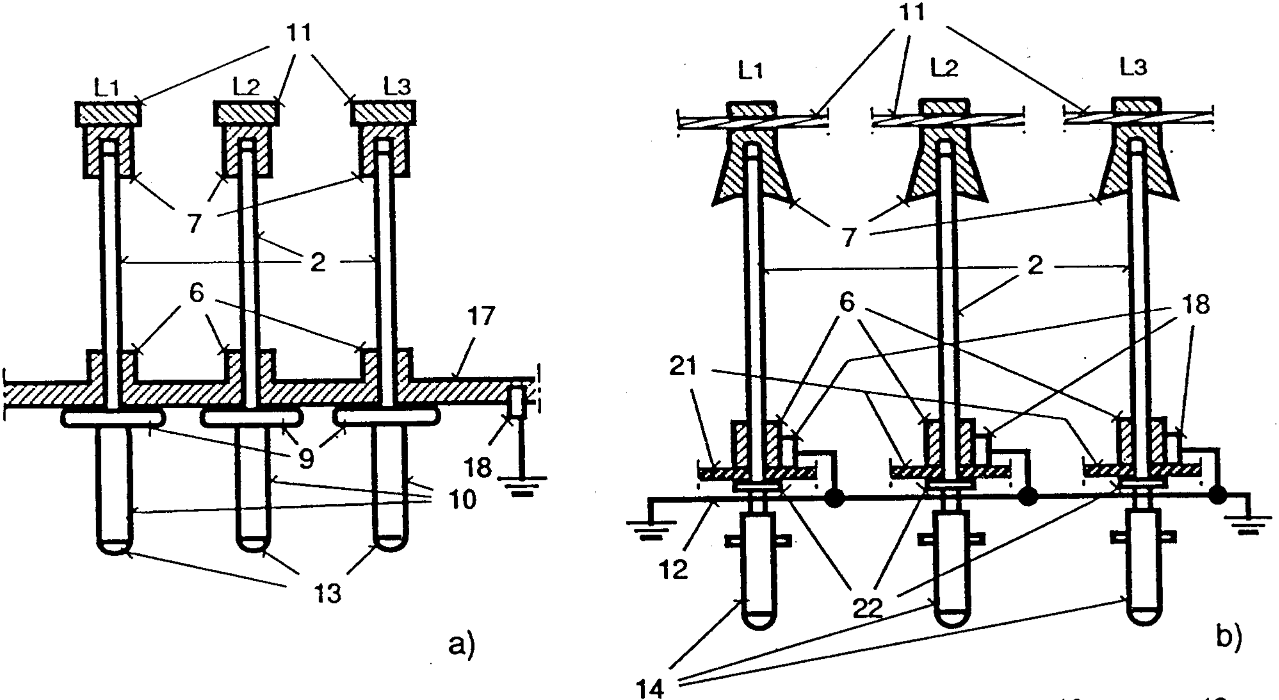
a) with earthing cable

b) with earthing lance contact

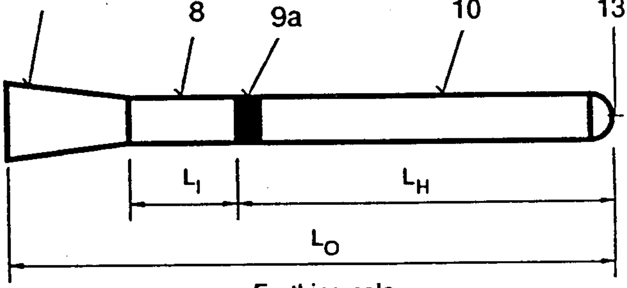


1	Earth clamp
2	Lance
4	Earthing cable
5	Short-circuiting and mechanically uniting frame
7	Line lance contact
9	Handguard
10	Insulating handle
11	Installation conductor
13	End cap of handle
15	Guiding component
18	Earthing cable connection
21	Mechanical support

Figure 2 – Illustration of multiple lance



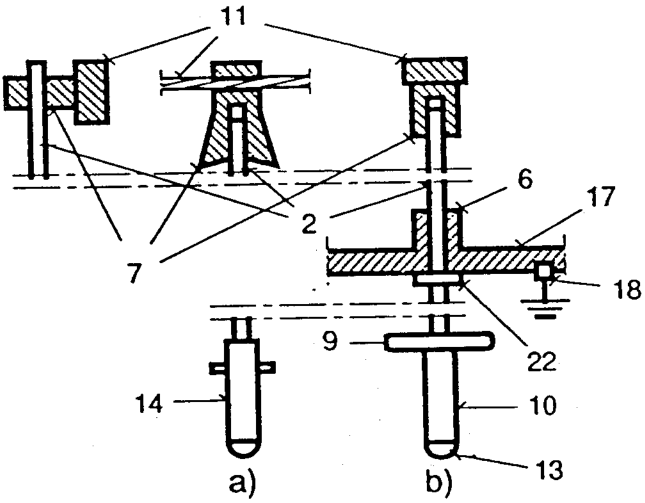
L_I	length of insulating section
L_H	length of handle
L_O	overall length of earthing pole



Earthing pole

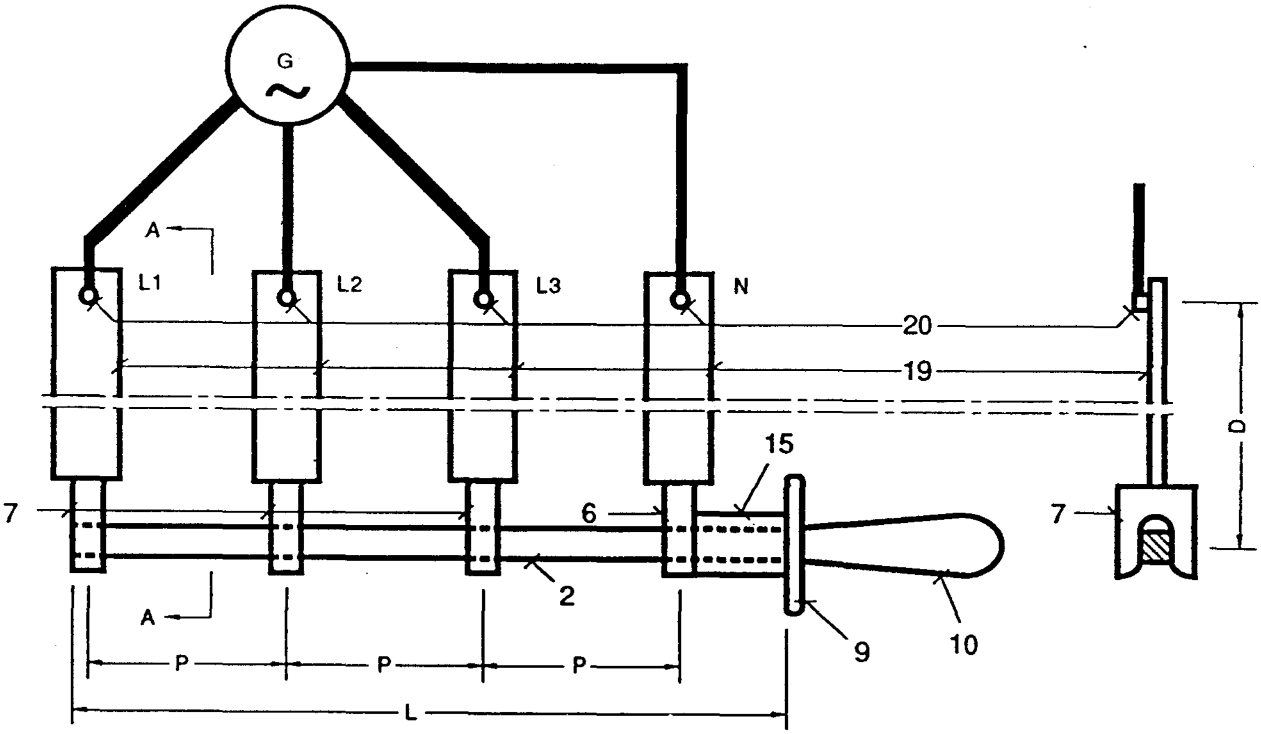
2	Lance
6	Earthing lance contact
7	Line lance contact
8	Insulating section of earthing pole
9	Handguard
9a	Handguard or handle limit marking
10	Insulating handle
11	Installation conductor
12	Earthing system
13	End cap of handle or earthing pole
14	Part of detachable coupling
17	Earthed short-circuiting bar (part of earthing system)
18	Earthing system connection
21	Mechanical support
22	End stop

Figure 3 – Illustrations of multi-phase lance earthings with a set of single lances



2	Lance
6	Earthing lance contact
7	Line lance contact
9	Handguard
10	Insulating handle
11	Installation conductor
13	End cap of handle or earthing pole
14	Part of detachable coupling
17	Earthed short-circuiting bar (part of earthing system)
18	Earthing system connection
22	End stop

Figure 4 – Illustrations of single-phase lance earthings



D Distance from test current feed-in point to lance centre: 1 m.
P Maximum distances between test set-up conductor centres permitted by the lance length.
L Total length of lance conductor.

2 Lance
6 Earthing lance contact (electrically isolated in the test set-up)
7 Line lance contact
9 Handguard
10 Insulating handle
15 Guiding component
19 Test set-up conductor
20 Test current feed-in point

Figure 5 – Typical test set-up for multi-phase lance earthings with one single lance (used for voltages ≤ 36 kV)

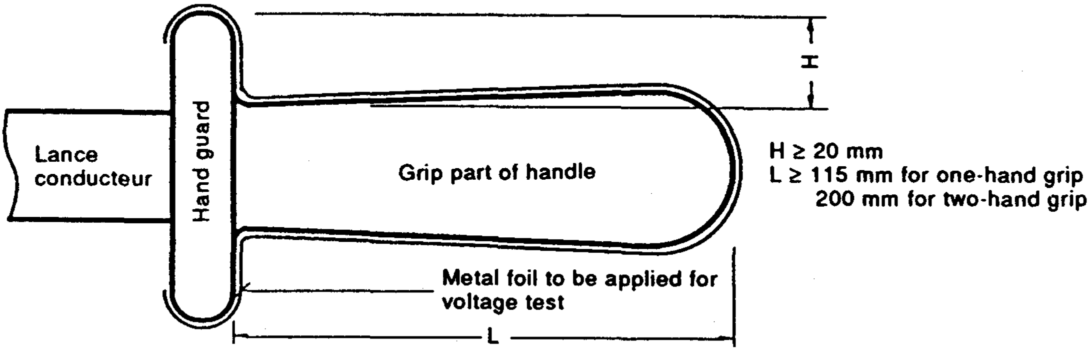
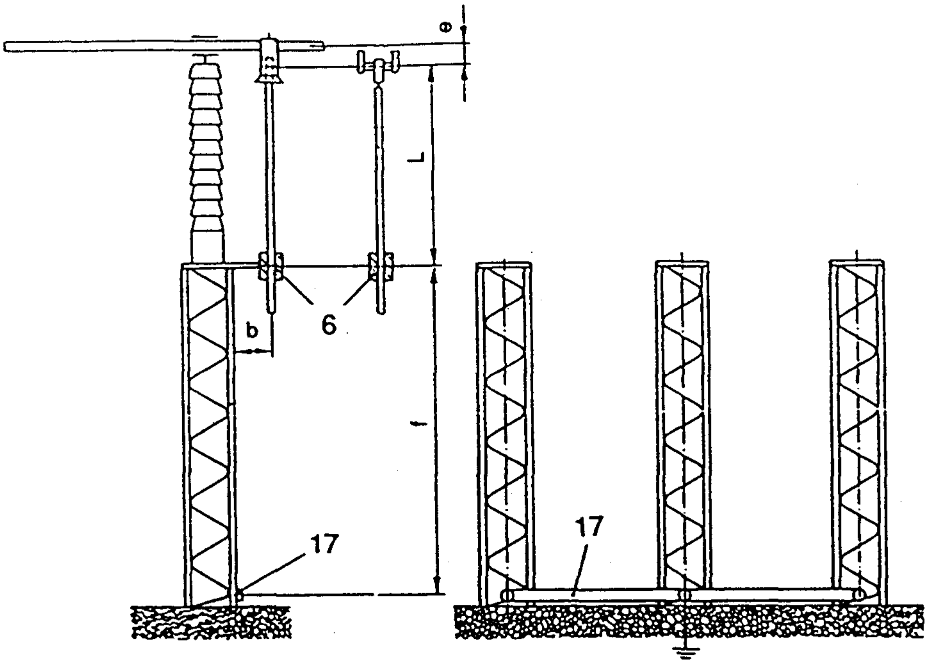


Figure 6 – Insulating handle and its preparation for voltage test



b Distance between lance and current transmitting mechanical support.
e Distance between test set up conductor and the centre line of line lance contact.
f Distance between earthing lance contact and earthed short-circuiting conductor.
L Distance between the centre of line lance contact and the centre of earth lance contact (see annex B).

6 Earthing lance contact
17 Earthed short-circuiting conductor (part of earthing system)

Figure 7 – Typical set-up for lance earthings with voltages > 36 kV

Annex A
(normative)

Sampling procedure

Sampling, acceptance and rejection

The following table gives the sample size and number of defectives for acceptance and rejection for a given batch or lot size. It is based on table II-A of IEC 410: Single sampling plans for normal inspection, with the following requirements.

Unit of products:	As defined in requirement clause
Batch or lot:	Series of running production (or delivery if agreed between customer and manufacturer)
Acceptable quality level (AQL):	2,5
Inspection level:	S-4 for batch or lot sizes up to and including 1 200 S-3 for batch or lot sizes above 1 200

Table A.1 – Single sampling plan for normal inspection

Batch or lot size	Sample size	Acceptance number of defectives	Rejection number of defectives
2 to 150	5	0	1
151 to 1 200	20	1	2
1 201 to 35 000	20	1	2

NOTE - If the batch or lot is of an isolated nature, special guidance is given in 11.6 of IEC 410.

Annex B
(normative)

Short-circuit testing in a standardized test set-up of multi-phase devices using a set of single lances

B.1 A standardized test set-up for three-phase devices is illustrated in figure 7. A device shall be tested in test set-up(s) with P-and L-distances most similar to the phase-to-phase and phase-to-earth distances of the system(s) for which it is designed. Five dimensions of test set-ups with type designations A to F are given in table B.1.

Table B.1 – Guide values for test set-up dimensions

Voltage kV	Test set-up type	Distances according to figure 7 m		
		P	L	D
≤ 36	A	0,15	0,15	≥ 1
	B	0,4	0,4	
> 36	C	0,8	0,8	≥ 2
	D	1,5	1,3	
	E	3,0	2,3	
	F	5,0	3,5	

B.2 One external single lance to which the maximum peak short-circuit current is not applied may be replaced by a connection of equal mechanical behaviour and electrical impedance.

B.3 A short-circuit test performed with a type of test set-up in accordance with table B.1 can also form the basis for accurate calculation of acceptable stresses in devices using other lance sizes and conductor distances.

Annex C
(normative)

Selection, use and maintenance of lance earthings

C.1 General

The aim of earthing and short-circuiting of disconnected parts of installations is to prevent dangerous voltages and arcs from arising due to unintentional energizing. Materials shall be co-ordinated with the temperatures reached after a short-circuit so as not to produce toxic gases which could impede the evacuation of personnel and which could cause serious poisoning even by short exposure or which could permanently damage installations and buildings. See annex A.1 of IEC 1230.

Where lances can be used as substitutes for unguided devices, they offer certain advantages.

C.2 Advantages of using lance earthings

Guiding reduces the weight dependance and thus facilitates temperature reduction. Other advantages of using lance earthing instead of unguided portable earthing equipment vary with the field of application.

Used in open switchgear and overhead lines, the major advantage of using lance earthings is that there is less hazard from uncontrollable movements.

When used in metal-enclosed switchgear and controlgear assemblies, the lance earthing technique has the additional advantage of facilitating earthing and short-circuiting without opening the enclosure. Earthing and short-circuiting without opening the enclosure is therefore a substantial safety improvement. This is most obvious if the enclosure is tested with an arc due to an internal fault and the lance earthing does not reduce the degree of enclosure protection. A further safety improvement can be obtained from a non-solidly earthed system with a disconnecting earth fault protection if the lance is stopped in a position where only one phase is earthed for as long a time as is necessary for earth fault disconnection.

Lance earthings shall of course be sized and tested for the worst conditions to which they can be exposed in practice, taking into account, for example, the reliability of protections and the risk of reclosure. In FBAs (factory-built assemblies) of low-voltage switchgear and controlgear, it is often necessary to integrate the earthing equipment in very compact installations. Gauging for continued use after short-circuit exposure is important. In this field, current-limiting fuses and circuit breakers are available. Requirements on the earthing equipment can be substantially reduced by combining it with an effective current-limiting protection.

C.3 Maintenance and disposal

For safety reasons, earthing and short-circuiting equipment shall be handled with great care. Lances shall be inspected before each application. Surface defects, deformations and any play in the guidance shall be adjusted immediately. If damage to the protecting cover or exposure of the bare conductor of earthing cables is noticed, disposal shall be seriously considered.

Equipment that has been exposed to a short circuit shall always be thoroughly inspected. If it is not designed for continued use after short-circuit exposure, it shall be disposed of unless thorough investigation, calculation and inspection guarantees that the exposure has been too moderate to influence its perfect condition. If fuses are involved and activated, the whole set of fuses shall be replaced.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60439-1 (1984) Low voltage switchgear and controlgear assemblies — Part 1 : Type tested and partially type-tested assemblies	IS 8623 (Part 1) : 1993 Specification for low voltage switchgear and controlgear assemblies: Part 1 Requirements for type-tested and partially type tested assemblies (*first revision*)	Identical
IEC 60479-1 (1984) Effects of current passing through the human body – Part 1 : General aspects	IS 8437 (Part 1) : 1992 Guide on effects of current passing through human body: Part 1 General aspects (*first revision*)	do
IEC 60855 (1985) Insulating foam-filled tubes and solid rods for live working	IS 13770 : 1993 Insulating foam-filied tubes and solid rods for live working	do

The technical committee responsible for the preparation of the standard has reviewed the provisions of the following International Standards referred to in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

IEC 61138 (1994)	Live working — Cables for portable earthing and short circuiting equipment
IEC 61230 (1993)	Live working — Portable equipment for earthing or earthing and short-circuiting
IEC 61235 (1993)	Live working — Insulating hollow tubes for electrical purposes

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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